Space Weather Technical Forecast

Issued on Wednesday, 02 February 2022 at 13:05 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Slight chance of G1 Minor Storms during day 1 into day 2 (2nd / 3rd February) from CME effects. Chance M-flares (R1/R2 Radio Blackouts).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Low with a number of C-class flares observed, the majority of these originated from AR2940 (Dsc/Beta) near the northeast limb and AR2939 (Esi/Beta) in the southeast quadrant. Currently the largest region, AR2936 (Eho/Beta) produced the largest flare, with a C9 observed at 01/2236UTC, and associated plasma eruption. Early indications are that although much of the plasma was reabsorbed, a CME is likely. Further coronagraph imagery is needed to confirm this, and to establish whether there is an Earth-directed component. The final sunspot region is a simple stable beta region. No other Earth-directed CMEs were observed in available imagery in the last 24 hours, although a few have launched off the west limb.

Solar Wind / Geomagnetic Activity: The solar wind, as observed at L1, started the period around 400-420km/s, before the arrival of the CME (launched from the Sun on the 29th Jan) at L1. This brought an interplanetary shock (sudden impulse) at 01/2200UTC, with solar wind speeds increasing to 480km/s. Density has been below average, before rising to slightly above average, with the arrival of the CME. Total interplanetary magnetic field strength, Bt, was mostly weak at around 5nT, before suddenly increasing to moderate on arrival of the CME, with a peak of 14nT at 01/2300UTC. Since then, there has been a gradual decline back to around 7nT. The corresponding Bz was between +5nT and -3nT, before a sudden drop to -13nT at 01/2229UTC, associated with the arrival of the CME. From around 02/0000UTC however, the Bz has been predominantly positive. The Phi angle was mostly positive (away from the Sun). Geomagnetic activity was mainly Quiet (Kp 1-2), with an Unsettled interval (Kp3) at 01/2100 to 02/0000UTC, and an Active (Kp 4) interval from 02/000 to 02/0300 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) measured at GOES 16 was at background levels. The high energy electron flux (greater than 2MeV), started at moderate levels, before rising to high levels at the diurnal peak, with a peak value of 2130 pfu at 01/1730UTC, before dropping back to background levels from 01/2235 UTC. The associated 24-hour electron fluence has been steady just below the Active threshold (1e8 integrated flux), with 7.1e7 recorded at 02/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be mainly Low to Moderate, with a chance of isolated M-class flares, most likely from AR2939, AR2940 or AR2936. There is also a very slight chance (5%) of X-class flares from any of these three regions depending on how they develop over the coming days.

Solar Wind / Geomagnetic Activity: A CME which left the Sun on 29 January arrived at Earth overnight on the 1st Feb. Solar winds are expected to remain slightly elevated during day 1 (2nd Feb) under the weak influence of the CME, before waning back to background levels early on

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day 2 (3rd Feb) and into day 3 (4th Feb). Solar winds may then become elevated by day 4 (5th Feb) due to a fast wind from coronal hole 49. As the effects of the weak CME wane, geomagnetic conditions are likely to remain mostly quiet, although still with a chance of active (kp4) intervals and a slight chance of G1 Minor storm intervals (Kp5) during day 1 (2nd Feb) into day 2 (3rd Feb). Active intervals are then possible later on the 4th and into the 5th February due to coronal hole 49's high speed wind arriving at Earth.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is forecast to be at background levels but with a slight chance of rising close to or just above the S1 level given any significant M-flaring, predominately from AR2936 if it remains unstable as it rotates across to the western limb. The high energy electron flux (greater than 2MeV) is likely to remain at background to moderate levels, although possibly with a rising trend over the next 4 days. The electron fluence is expected to remain just below the Active (1e8 integrated pfu) threshold for the time being.

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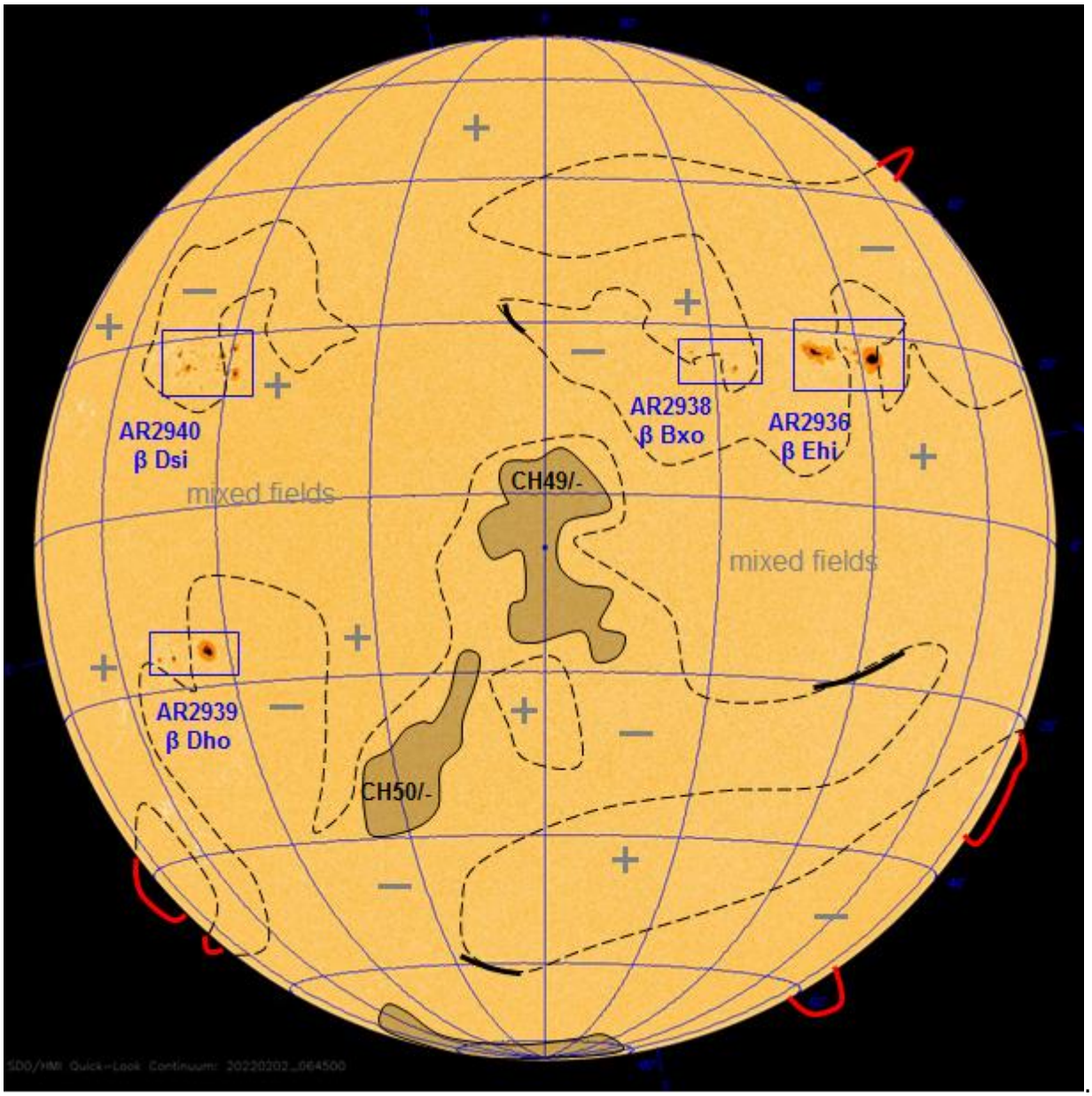
Figure 1. Solar Analysis Valid 02/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A full halo CME (which is more directed at Stereo A) on 29 January arrived at Earth overnight on 1st February. With Bz only briefly becoming negative the impacts were minimal. Solar winds are expected to remain slightly elevated during day 1 (2nd Feb) under the weak influence of the CME, before waning back to background levels early on day 2 (3rd Feb) and into day 3 (4th Feb). Solar winds may then become elevated by day 4 (5th Feb) due to a fast wind from coronal hole 49. As the effects of the weak CME wane, geomagnetic conditions are likely to remain mostly quiet, although still with a chance of active (kp4) intervals and a slight chance of G1 Minor storm intervals (Kp5) during day 1 (2nd Feb) into day 2 (3rd Feb). Active intervals are then possible later on the 4th and into the 5th February due to coronal hole 49's high speed wind arriving at Earth. There is some uncertainty on the arrival of the high speed stream, but speeds of 500-600km/s are possible based on persistence.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	20	20	10	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: DSCOVR / ACE data showing the arrival of the anticipated CME.

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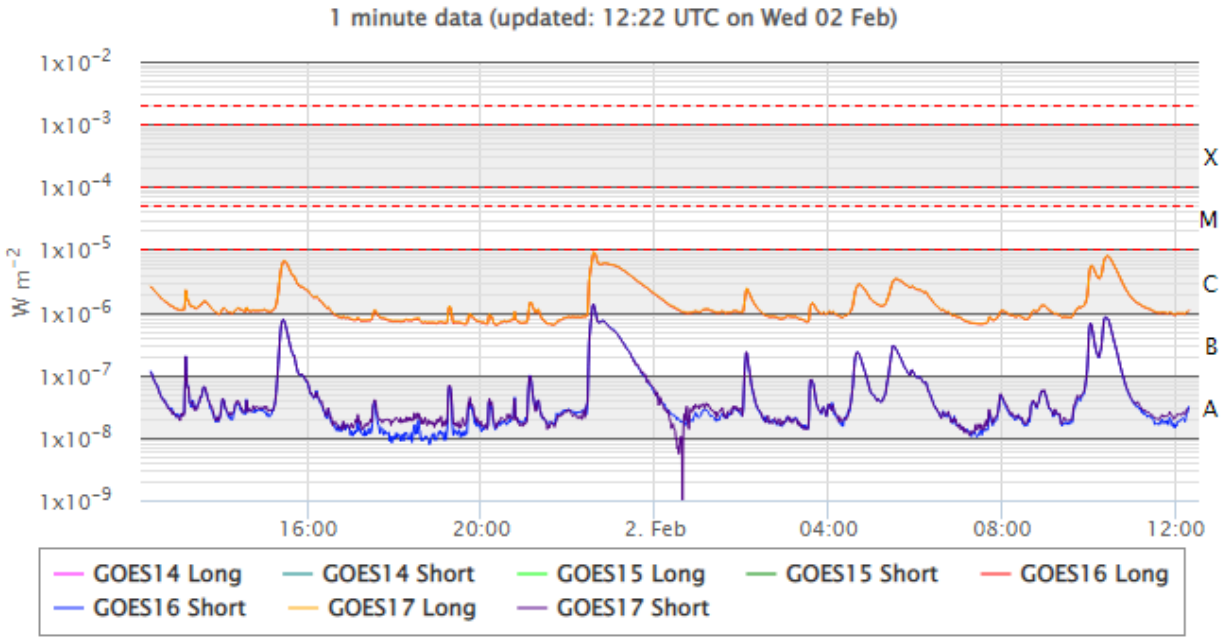
Radio Blackouts - X-Ray Flares:
Solar activity is low, with frequent low level C-class flares, mainly from AR2940 and AR2939. These two regions are so far only showing Beta-style magnetic arrangements, which keeps them relatively stable and quiet, albeit AR2940 especially has a significant number of individual mature sunspot regions moving around in a compact fashion, which explains why this is the brightest region in the EUV spectrum.

AR2936 (Eho/Beta) in the northwest sector is the largest region, which has been mostly stable, until recently, when it produced a long duration C9 flare at 01/2236UTC and an associated plasma ejecta, which is likely to produce a CME, although still awaiting coronagraph imagery to confirm. This region may still pose a threat of proton storms due to its current Carrington location.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	30	30	30
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: X-ray flares from the previous 24 hours, as measured by GOES



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Solar Radiation Storms - (High Energy Protons):
The high energy proton flux, as measured by GOES-16 is at background levels. Solar radiation storms are not likely in the period, however there is a slight chance (5%) for proton fluxes to rise given any significant flaring, predominately from AR2936 in the northwest quadrant if it becomes unstable and flares significantly.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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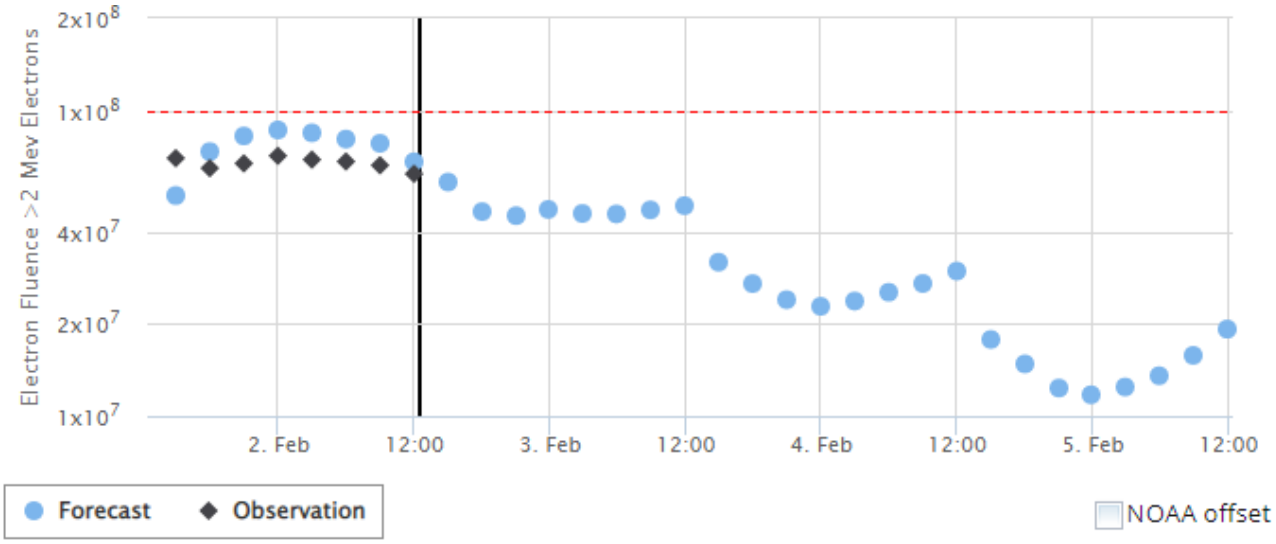
High Energy Electrons Event (≥ 2MeV):
The high energy electron flux (greater than 2MeV) has been occasionally at high (1e3 pfu) levels recently with the recent high wind. The 24-hour fluence has topped out at 7.1e7pfu and is unlikely to rise any further during the next 2 days. Any further Geomagnetic activity from the arrival of the CME should tame these levels further, however the after-effects of the CME during days 3 and 4, along with the arrival of a high speed stream may cause it to rise again, although with some uncertainty.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	20	20	30	30
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 4: The latest REFM, showing actual and forecast fluence values. There is a chance that fluence could rise towards the end of the period, but this is low confidence.



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